HONG KONG INSTITUTE FOR MONETARY RESEARCH

FISCAL CRISIS RESOLUTION: TAXATION VERSUS INFLATION

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HKIMR Working Paper No.10/2004

May 2004

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Abstract

This paper presents a model of fiscal and monetary policy that evaluates the tradeoff between higher distortionary labor taxation and higher inflation in the resolution of fiscal crises. Fiscal crises arise because of exogenous fiscal transfer spending shocks. Government debt is domestically held and nominal.

Data are presented to show that such debt is now at least as important as external government debt in many key emerging markets, and that it is a very important item on the balance sheets of domestic financial intermediaries, despite the gradual disappearance of financial repression. An important reason is that government debt helps to alleviate informational asymmetries, especially in less developed financial markets. In the model government debt therefore enters the economy's intermediation technology. The key contribution of this mechanism is that it makes unanticipated inflation costly. Price level determination then becomes the result of an explicit government optimization problem over a tax distortion and an inflation distortion. Higher taxes have a distortionary effect on labor supply, but also a beneficial effect by lowering inflation and supporting a higher public debt stock that in turn supports intermediation and the capital stock.

In such a model first period price level jumps generally do not contribute to the resolution of fiscal crises. Instead ongoing but modest inflation is used to levy seigniorage on debt. This gives rise to a fiscal theory of inflation whose transmission mechanism does not rely on base money seigniorage. It is found that a large contribution of inflation to the resolution of a fiscal crisis is only optimal when the fiscal shock is transitory, while a long lived shock is optimally financed mostly through taxes.

The author thanks Guillermo Calvo, Bob Hall, Ken Judd, Enrique Mendoza, Evan Tanner, Mark Wright and seminar participants at UC Santa Cruz and Stanford for helpful comments. Major parts of this research were completed while the author visited the Hong Kong Institute for Monetary Research, the Research Departments of the IMF and the IDB, and the IMF Institute. Their support is very gratefully acknowledged.

1. Introduction

This paper analyzes the tradeoffs arising in the optimal choice of a fiscal and monetary policy response to serious fiscal imbalances, an issue that has been at the heart of several recent emerging markets crises. In the model, fiscal crises arise through exogenous real transfer spending shocks. Debt is nominal, labor taxation is distortionary, and crises can be resolved either through an increase in distortionary taxation or through higher inflation. The key innovation is that unanticipated inflation is distortionary, due to its effect on the intermediation technology of the economy.

This research was motivated by a number of International Monetary Fund fiscal adjustment programs in emerging markets, a survey of which can be found in International Monetary Fund (2003). The paper suggests a model to characterize some dimensions of the optimal design of such programs, subject to constraints that are typically encountered in practice. The maintained assumption is that the government is able to fully commit to the optimal program,[1] and that the program is completely successful in restoring solvency and maintaining credibility.

At its most basic level, the evaluation of a country's fiscal solvency requirements often does not go beyond mechanical manipulations of the government budget constraint as an accounting identity. In such an exercise one imputes values for the expected primary budget surplus, seigniorage revenue, the real GDP growth rate and the real interest rate. If they do not put total real government debt on a stable path, one computes the required adjustments in government spending or taxes. An example of this type of analysis is Blanchard et al. (1990). A critical underlying assumption is that debt is both real and non-defaultable. This means that outright default on real or nominal debt is not allowed to make a contribution to crisis resolution. Similarly, monetary policy and changes in the price level are only allowed to contribute to restoring fiscal solvency through higher seigniorage on base money, as in Sargent and Wallace (1981), not through a change in the real value of a nominal debt stock. However, many emerging markets' fiscal crises point to the limits of this approach. Prolonged political resistance to tax increases and/or spending cuts often lead to an overaccumulation of debt that can ultimately only be resolved through a partial default, or in the case of nominal debt through a large jump in the price level/exchange rate, referred to here as a debt devaluation.

When discussing such debt devaluations as part of a fiscal adjustment program in an open economy, economists and policymakers generally focus on the sum of externally and domestically issued public debt, while turning to the sovereign debt literature for guidance. The latter is, however, exclusively concerned with externally issued and held debt. At the same time, as emphasized in an important paper by Reinhart et al. (2003), domestically issued government debt has become an increasingly important part of overall financing for emerging market governments, representing close to or more than half of total public debt. In almost all cases most of this debt is denominated in domestic currency.[2] And most importantly, it is typically held by domestic residents. Judging such debt by the criteria of the sovereign debt literature overlooks important differences in the relevant economic criteria. And given its share in total public debt, this omission is not trivial.

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1 Commitment is, of course, one major reason for adopting an International Monetary Fund adjustment program.

2 In some cases this domestic currency debt is indexed to some other market variable. It is typically of short maturity.

In the *sovereign debt* literature[3] the main benefit of a debt default is the resource transfer from foreign creditors, with a secondary benefit of lower distortions from the taxation required to service the debt. Because of the former, foreign creditors have to be able to credibly threaten the debtor with a punishment, typically exclusion from future borrowing. Contracts are then designed to ensure that default never occurs in equilibrium. This feature is problematic when thinking about actual fiscal crises, which are frequently resolved in part through a debt default (or debt devaluation). The tension arises because in this literature the debt to GDP ratios that can be sustained in equilibrium are counterfactually low,[4] because the cost of feasible punishments tends to be small relative to the large benefit of defaulting. This paper claims that this calculus is very different for domestically held debt. The main argument, motivated both empirically and theoretically below, is that devaluations of domestically held debt have high economic costs through their effect on domestic financial intermediation. It is true that the benefits are also much smaller because there is no resource transfer, domestic debt holders effectively owing the public debt to themselves. But this by itself is not sufficient to discourage a debt devaluation in response to a fiscal shock, because the considerable benefit of lower distortionary taxation remains. This is indeed the conventional result in the literature on *domestic debt*, which finds that debt is optimally the main shock absorber for spending shocks. But this is evidently not how policymakers behave, debt devaluations being as fiercely resisted as tax hikes when there is a serious fiscal crisis. What is needed therefore is a theory that makes the real value of public debt dependent on fiscal policy while reflecting and making sense of the concern of policymakers with the costs of debt devaluations.

The earliest theory linking fiscal policy to the determination of the real value of nominal public debt is the fiscal theory of the price level. It assumes that the price level jumps to equalize the real value of nominal public debt to the present discounted value of primary surpluses.[5] The key characteristic of this theory is that primary fiscal surpluses are assumed to be exogenous, while in traditional monetary theories they are endogenous to monetary policy. If the nominal debt stock is large enough relative to the size of the shock, debt can then act as the sole shock absorber for fiscal shocks. Importantly, this function of debt does not create any distortions, it acts as a capital levy. This theory has been challenged on both empirical and theoretical grounds. Empirically, for the US case, Canzoneri et al. (2004) find strong evidence against the fiscal and in favor of monetary theories of price level determination. This is plausible, because the US has a strong tax base that can respond flexibly to fiscal solvency needs. But in emerging markets' fiscal and debt crises, to the extent that they involve nominal debt, the fiscal dimension of price level determination becomes much more obvious. These countries typically have a narrow and weak tax base,[6] and in addition International Monetary Fund negotiations often contend with strong political opposition to tax increases. Fiscal dominance over monetary policy is, therefore, a serious problem, and the resolution of such fiscal crises almost always involves a large jump in the price level

3 See Eaton and Fernandez (1995) for a survey of the earlier literature. Recent contributions have stressed repeated game aspects, and include Cole and Kehoe (1998) and Wright (2002). This literature exclusively considers real debt.

4 Arellano and Heathcote (2003) obtain sustainable debt to GDP ratios of around 1% to 3%.

5 Key contributions to this literature are Cochrane (1998), Sims (1994) and Woodford (1996, 1998, 2001). A long list of additional references is contained in Cochrane (1998, 2000) and Woodford (2001).

6 See Gavin and Perrotti (1997) for detailed evidence for Latin America.

and exchange rate that reduces the real value of nominal government liabilities. The theoretical critique of the fiscal theory of the price level concerns the nature of the government's intertemporal budget constraint.[7] But a more general critique is that neither the assumption of completely exogenous, nor that of completely endogenous, primary surpluses is based on a theory of optimal government choice.[8]

The optimal fiscal policy literature (Chari and Kehoe, 1999), which assumes distortionary taxation, is less vulnerable to this latter critique. But, because unanticipated price level jumps are again non-distortionary, the model continues to heavily favor inflation over taxation in response to fiscal spending shocks.[9] In addition the government is now faced with a time inconsistency problem, because distortionary taxation gives it an incentive to inflate away the entire debt stock in its initial planning period. The literature deals with this problem in one of two ways. The first (Calvo and Guidotti, 1993; Chari and Kehoe, 1999) is to assume that the first period price level is arbitrarily fixed while the policymaker can commit to future policies. However, ruling out changes in the initial price level is a very strong assumption when analyzing the resolution of a serious fiscal crisis. At such moments governments have to choose between a number of painful options, and there is no reason why a measure that reduces the real debt burden would not be one of them. The same should be true for the model. The second way of dealing with time inconsistency is to model the cost of debt devaluation as a loss of the policymaker's credibility which forces the economy to settle on an inferior equilibrium in subsequent periods. The policymaker then has to trade off this cost against the one-off benefit of an inflationary surprise. But for an emerging economy faced with a serious fiscal imbalance, this way of modeling the policymaker's decision problem has its own problems. First, and this is a general problem in this literature, the choice of the inferior equilibrium following an inflationary surprise is somewhat arbitrary. Second, and related to the previous point, when the public is fully aware of the fiscal problems because of their severity, it is not clear that delaying a debt devaluation should have a positive effect on the credibility of the policymaker. Third, especially for the large debt devaluations required to restore solvency in emerging markets fiscal crises, there is a much more obvious and immediate cost to the government. This is that the inflationary erosion of the public debt stock can have severe effects on the health of already fragile financial systems, which tend to hold large amounts of such debt.[10] This has, for example, been a key consideration in the recent Argentinian crisis, but that is only the most extreme example of many. Further evidence on this point will be provided in Section 2.

This suggests a crucial new model ingredient – costly unanticipated inflation. Its implication is that the trade-off between taxation and inflation as a fiscal shock absorber need no longer be heavily biased in favor of inflation.[11] Costly unanticipated inflation is a feature of the model in Section 3 due to a financial

7 See e.g. Buiter (1998, 1999) on the one hand, and Woodford (2001) on the other. Bassetto (2002) clarifies this debate.

8 The same is also true for the literature on fiscal reaction rules, see e.g. Johnson (2003).

9 Chari and Kehoe (1999) find that in theirmodel around 80% of spending shocks is optimally absorbed by the price level, because varying the real return on bonds has a very low cost.

10 Of course the paper does not suggest that credibility considerations should be disregarded. They should be seen as complementary to the approach proposed here, and are probably more important for industrialized countries.

11 Calvo (1988), in a very insightful paper, obtains such a tradeoff by assuming an ad hoc cost function for unanticipated inflation. Calvo and Guidotti (1993) and Chari and Kehoe (1999) stress the importance of improving the understanding of the microfoundations of costly unanticipated inflation.

constraint that makes the stock of intermediated physical capital dependent on the stock of government debt. Under this assumption it becomes possible to combine the main advantages of the fiscal theory of the price level and of the optimal fiscal policy literature. As in the former, a finite first period price level can be determined. And as in the latter, price level determination is the outcome of an explicit government optimization problem. Higher taxation distorts the labor supply decision, but it also allows the government to service a higher debt stock that in turn lowers inflation and supports a higher physical capital stock.

International Monetary Fund programs for countries in fiscal difficulties typically stipulate that changes in taxation must be front-loaded and that thereafter the primary balance should be kept constant relative to output. This is documented in Chalk and Hemming (2000). There are several reasons for ruling out highly variable paths of labor tax rates. Most importantly, the political costs would be prohibitive because of the implied large redistributions between holders of financial assets and workers. Also, such policies would encourage tax evasion, and their implementation would have high resource costs in countries where tax administration is already weak and inefficient. Ruling out such tax paths is therefore a much more plausible assumption than restricting the initial price level. The paper incorporates this constraint by assuming that the government is only allowed to choose one constant tax rate τ^{opt} for any given sequence of government spending $\{g_t\}_{t=0}^{\infty}$. It is shown that under this restriction there is a unique tax rate at which there is no incentive for time inconsistent government behavior. That tax rate is too low in terms of steady-state welfare because the financial constraint binds and long-run capital taxation (via the inflation tax on debt) is nonzero. In other words, both the labor tax distortion and the inflation tax distortion are present at that optimum.

Under these assumptions the model explores, by way of a computed example, the optimal fiscal response to exogenous fiscal transfer spending shocks. The model has several novel and interesting implications. First, for the most plausible choice of initial conditions, the initial price level does not contribute at all to the restoration of fiscal solvency. Instead, the shock absorber role of debt works through higher inflation, in other words through seigniorage on debt. Given the size of the debt stock, the required increase in inflation is not very large even for a substantial spending shock. As for the burden-sharing between taxation and inflation in the computed examples, permanent spending shocks call for around three quarters of the increase to be optimally financed through higher taxes. More transitory shocks call for a larger contribution of inflation.

The rest of the paper is organized as follows. Section 2 discusses empirical evidence from emerging markets on the relative importance of domestic versus external public debt, and on the importance of that debt in domestic financial systems. The section concludes with a motivation for the theoretical modeling of government debt adopted in the following sections. The theoretical model is presented in Section 3. Section 4 discusses some computed examples of optimal policy responses to fiscal shocks. Section 5 concludes. The Appendix contains some preliminary results discussed in Section 4. A separate Technical Appendix[12] contains details of the computational methods used to compute the solutions in Section 4.

[12] This is available from the author on request.

2. Government Debt in Emerging Financial Markets

Table 1 shows that for several of the most important emerging markets, domestic government debt represents close to or more than half of total government debt.[13] Furthermore, in almost all cases (Argentina being the main exception) the majority of this debt is denominated in domestic currency. It is quite clear that this debt class deserves as much or more attention than external debt.

Reinhart et al. (2003) make several additional points that will be reflected in the assumptions of the model. First, for many of the countries listed in Table 1 the cause of high domestic debt stocks has been the recapitalization of an insolvent domestic banking system following a crisis. In the model, government spending shocks are pure transfers. Second, in many emerging markets bank holdings of government debt are no longer primarily due to government financial repression. Recent increases in emerging market debt financing costs are precisely due to a switch from forced borrowing at low interest rates to borrowing through marketable debt at market-based interest rates.[14] In the model, agents choose to hold government debt mainly to satisfy a financial constraint that is due to imperfections in private financial markets.

Figure 1 presents data on public debt held by domestic banking systems in a large number of emerging (and, for comparison, industrialized) economies.[15]

It is worth remembering that the typical bank capitalization ratio is less than 10% of assets, so that extending credit to the public sector on the order of magnitude shown exposes banks to a very high insolvency risk if the public sector runs into serious difficulties. This is indeed exactly what happened in Argentina.[16] Perry and Serven (2002) conclude that "...the roots of the [Argentinian] crisis lie in the ... rigid exchange rate regime, the fragile fiscal position, and the hidden vulnerability of the banking system behind its strong facade..." . During the protracted negotiations that eventually led to Argentina's massive default, it was a key consideration that a large government default would seriously harm the banking system. But Argentina is only the most extreme of many such cases in emerging markets. Existing models fail to capture this concern.

The theoretical model of this paper does introduce a link between the real stock of government debt and financial intermediation, and in turn between financial intermediation and production. It does so through a financial constraint whereby the capital stock has to be intermediated and a certain fraction of

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[13] The table is reproduced from Reinhart et al. (2003). We thank Carmen Reinhart for her permission to use the data. Batlay and del Valle (2002) present very similar evidence for a large number of Eastern European and Central Asian countries. In that region domestic currency denominated domestic debt is even more prevalent than in the countries in Table 1.

[14] Caprio (1999) also discusses evidence to this effect.

[15] The percentage figures are computed from International Financial Statistics, and are averages for 1998-2002. The numerator is the sum of all entries representing net credit to the public sector by depositmoney banks, other banking institutions and nonbank financial institutions (the latter series do not exist for all countries). The denominator is the sum of the net total assets of these three groups, after cancelling out credit items between them. To obtain the net figures we deduct from both numerator and denominator the sum of all entries representing credit by the public sector to these institutions.

Crisis years are excluded from the computation of averages as follows: Argentina 2002, Indonesia 1998.

[16] Although in that case, contrary to our formal model, public debt was largely denominated in US dollars and only converted to local currency as part of the eventual default.

the associated borrowing has to be collateralized through government debt in order to alleviate moral hazard problems. In other words, government debt improves the economy's intermediation technology. This way of modeling government debt turns out to be functionally equivalent to a model where bonds enter the production function directly.

Fry (1997) contains an excellent survey of several other important benefits of domestic public debt in emerging markets. One is that government debt serves as an informational benchmark and, as such, is useful for the development of private capital markets. Reinhart et al. (2000), in discussing the disappearance of US government debt in the late 1990s, suggest that this liquidity function of government debt can in the US be quite easily replaced by high quality private sector financial assets. But the same is not true for emerging markets, precisely because there the historic lack of developed public debt markets has been an impediment to the growth of private capital markets. Reinhart et al. (2000) add that if it is the safety rather than the liquidity of government debt which investors value, the scope for market innovation to fill that gap may be much more limited. And, indeed, the riskiness of banks in emerging markets is generally held to be lower when they hold a relatively large proportion of their assets in the form of government debt. This is recognized by the Basle rules for capital adequacy, which give a much lower risk weighting to such debt, even if the debtor is an emerging market government. Many of these benefits of public debt, and others elaborated in the theoretical literature such as Holmstrom and Tirole (1998), could be modeled using a reduced form production function that contains government debt as a direct argument.

A model where bonds enter the economy's technology is a close relative of several existing modeling traditions. Several authors have studied models with money in the production function, e.g. Mulligan (1997), Calvo (1979) and Benhabib et al. (2001). There is also a long tradition of research exploring the role of bonds in the utility function, including Friedman (1969), Barro (1974), Fried and Howitt (1983), Poterba and Rotemberg (1987), and Bansal and Coleman (1996). The financial constraint used in this paper builds on the recent literature on financial market imperfections, especially Kiyotaki and Moore's (1997) collateral constraint. The latter emphasize the role of moral hazard in private sector credit transactions. This paper adds the consideration that government debt can play an important role in alleviating moral hazard problems when legal systems, government regulations and market mechanisms are weak so that real assets are difficult to pledge as collateral.

In any economy the vast majority of capital is intermediated, and inter-company credit in the form of loans or trade credit forms a very large part of a typical company's balance sheet. For tractability and to facilitate welfare analysis the paper captures this not by modeling savers and users of capital as separate agents, but instead by a device similar to the Lucas and Stokey (1983, 1987) cash-in-advance model. As shown in Figure 2, the representative household consists of a consumer, a worker, a saver and a producer who pool resources during the opening of a securities market at the end of each period and then split at the beginning of the next period when goods and factor market open. The crucial aspect of this is that the saver and the producer are separate parties while production takes place. They require an intermediary, and the intermediary requires collateral.

The reason is moral hazard. Once capital is handed over to the producer, its inside value exceeds the outside value to the intermediary, giving the producer an incentive to default. This is the problem considered by Kiyotaki and Moore (1997), who explore the implications under two further assumptions. One is that any loan required to finance capital holdings needs to be fully covered by collateral. The other is that capital itself can serve as collateral. The model in the next section retains the first assumption, but it weakens the second. Specifically, it is assumed that all capital must be intermediated, but that the ability to use capital itself as collateral is limited so that government debt must serve as additional collateral. Quantitatively these assumptions can be made as weak as desired by assigning a low value for the required government debt collateral coverage ratio. A greater ability to use capital itself as collateral calls for a lower coverage ratio. So does more direct ownership of capital, which is equivalent to borrowing without government debt collateral in the model. The motivation for assuming that the use of capital as collateral is subject to limitations is that emerging financial markets generally have weak legal systems, weak or unenforced government regulations, and underdeveloped market mechanisms to alleviate informational asymmetries. This is documented extensively by de Soto (2000) and Pagano (2001). Under such conditions government debt represents an attractive alternative. Government debt is ultimately also backed by (taxes on) private income, but this derives from the pooled income of all agents, and is certified and securitized by the government, thereby removing moral hazard. In addition, government debt is technically easier to pledge than physical capital, and there is generally a liquid secondary market with a reasonably certain resale value. Several large emerging markets now also have active repo markets.

The presence of a financial constraint linking government debt and the capital stockgenerates a fiscal policy trade-off between distortionary labor taxation and distortionary inflation. This is illustrated in Figure 3, which shows household indifference curves and production possibilities frontiers between consumption and leisure. Labor taxation has two effects that work in opposite directions. It generates a wedge between the marginal rates of substitution and transformation between consumption and leisure, thereby reducing labor input for any given capital stock. But it also allows the government to service a larger debt stock and thereby to support more financial intermediation and a larger capital stock. The first effect implies a suboptimal allocation along a given production possibilities frontier, but the second effect shifts the production possibilities frontier itself outwards. At point A taxes are low and the labor supply distortion is moderate, but the financial constraint is tightly binding. A higher tax rate such as at B further worsens the former distortion, but it improves the latter. Beyond some maximum level of tax and debt, further debt no longer relaxes the constraint. The associated production possibilities frontier and allocation are shown in Figure 3 as PPF III and point C. The first-best at Z is unattainable because taxes are distortionary. This static analysis suggests that taxes should be raised all the way to where the financial constraint no longer binds. However, as will be shown below, dynamic considerations imply that the government can improve welfare by moving away from C to a lower tax rate and capital stock. This is so because welfare gains during the transition offset the lower welfare in the final steady state.

3. The Model

The economy is nonstochastic and consists of a representative household, an intermediary and the government. Output is homogenous and prices are flexible. The economy is closed to simplify the exposition. Introducing the possibility of holding international bonds would not qualitatively alter the results as long as these bonds are imperfect substitutes for domestic bonds in the intermediation technology.[17] The government sets two policy instruments, the nominal interest rate (monetary policy) and the labor tax rate (fiscal policy). Government transfer spending is assumed to be exogenous.

3.1 Households

Households derive utility from consumption c_t, leisure $1 - l_t$. It, and real money balances M_{t+1}/P_t, where P_t is the price level. Their rate of time preference is r, and the time unit is one quarter. Households' objective function is

$$Max \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t \left\{ (1-\kappa) \ln c_t + \kappa \ln(1-l_t) + v(\frac{M_{t+1}}{P_t}) \right\} . \tag{1}$$

The utility index $v(.)$ for real money balances is assumed to have a satiation point m^* at which $v'(m^*) = 0$. Households can also acquire nominal government discount bonds D_{t+1} at the price $D_{t+1}/(1+i^g_{t+1})$, where i^g_{t+1} is the policy determined nominal interest rate. Real bonds equal $d_t = D_t/P_t$, and the real interest rate is denoted by r^g_t. Capital accumulation is given by

$$k_{t+1} = (1-\delta)k_t + I_t \ , \tag{2}$$

where δ is the rate of depreciation and I_t is investment, which is subject to a quadratic adjustment cost of the form $(\frac{\xi}{2})(\frac{I_t}{k_t} - \delta)^2$. The producer's technology is Cobb-Douglas in labor L_t and capital K_t:

$$Y_t = L_t^{\alpha} K_t^{1-\alpha} \ . \tag{3}$$

To distinguish producer and worker/saver choices of production inputs, upper case is used for the former and lower case for the latter. The hiring of labor takes place in a spot market and capital has to be rented from the intermediary. To insure that it is returned to the intermediary after the closing of goods and factor markets, the producer must provide collateral. Because of financial market imperfections capital itself is insufficient as collateral so that government bonds and cash must be used in addition. This gives rise to the following financial constraint:

$$d_t + m_t \geq \gamma K_t \ . \tag{4}$$

The parameter r is part of the economy's intermediation technology, and reflects the combined effect of its legal, institutional and private financial market imperfections.

The timing of transactions in period 0 is as follows. At the beginning of the period the sequence of government transfer spending $\{g_t\}_{t=0}^{\infty}$ is realized. Then the government announces its monetary and fiscal policies $\left\{i^g_{t+1}, \tau_t\right\}_{t=0}^{\infty}$. Next, goods and factor markets open, and the household splits into a shopper, a worker, a saver and a producer who conduct independent transactions, all of which are on

[17] This is generally the case, for a number of reasons: First, international bonds are subject to different legal jurisdictions and therefore less suitable as collateral for local transactions. Second, holdings by financial intermediaries of international bonds are typically limited by regulations on currency mismatches. In Latin America (and several Asian countries) the private sector is typically a net debtor in international capital markets and a net lender to its own government.

credit terms. The **shopper** purchases consumption goods c_t from producers. The **worker** supplies labor to the labor market, and his real labor income $(W_t/P_t)l_t$ is subject to a proportional tax τ_t. The **saver** purchases investment goods I_t from producers, subject to an adjustment cost. He also deposits his existing capital stock k_t with the intermediary against the promise of a return of the (depreciated) capital stock after factor markets close, plus a competitive real return r_t^d. The **producer** receives the household's entire current holdings of cash and bonds when the household splits. This allows him to provide collateral to satisfy the financial constraint and therefore to rent capital,[18] and it gives him an incentive to return the capital when factor markets close. The intermediary receives the competitive marginal product of capital r_t^k. After goods and factor markets close, the shopper, worker, saver and producer reunite and a centralized securities market opens between the government and households. Here households settle all claims from the previous goods and factor markets transactions, they receive government transfers, pay their taxes, and acquire (or sell) nominal money $M_{t+1}-M_t$ and bonds $D_{t+1}-D_t$ from the government. Households' overall budget constraint therefore looks as follows:

$$\begin{aligned}\frac{d_{t+1}}{1+r_{t+1}^g} &= d_t + m_t - m_{t+1}(1+\pi_{t+1}) + w_t l_t (1-\tau_t) + r_t^d k_t \\ &\quad -c_t - I_t - \frac{\xi}{2}(\frac{I_t}{k_t}-\delta)^2 + g_t \\ &\quad +L_t^\alpha K_t^{1-\alpha} - w_t L_t - r_t^k K_t \ . \end{aligned} \tag{5}$$

Let the multiplier of the budget constraint (5) be given by λ_t, the multiplier of the capital accumulation identity (2) by $\lambda_t q_t$ (where q_t is the shadow price of installed capital), and the multiplier of the financial constraint (4) by μ_t. Then the following first order conditions for I_t, k_{t+1}, c_t, l_t, L_t, K_t, d_{t+1}, and μ_t are obtained:

$$q_t = 1 + \frac{\xi}{k_t}\left(\frac{I_t}{kt} - \delta\right) \ , \tag{6}$$

$$\lambda_t q_t = \frac{1}{1+r}\lambda_{t+1}\left(r_{t+1}^d + q_{t+1}(1-\delta) + (q_{t+1}-1)\frac{I_{t+1}}{k_{t+1}}\right) \ , \tag{7}$$

$$\frac{1-\kappa}{c_t} = \lambda_t \ , \tag{8}$$

$$\frac{\kappa}{1-l_t} = \lambda_t w_t (1-\tau_t) \ , \tag{9}$$

$$w_t = \alpha\left(\frac{K_t}{L_t}\right)^{1-\alpha} \ , \tag{10}$$

$$\mu_t \gamma = \lambda_t\left[(1-\alpha)\left(\frac{L_t}{K_t}\right)^{\alpha} - r_t^k\right] \ , \tag{11}$$

18 As these assets relax the producer's financial constraint, they are more valuable to him than to the rest of the household. It is therefore optimal to endow him with the entire stock of household financial assets while goods and factor markets are open.

$$\frac{\lambda_t}{(1+r^g_{t+1})} = \frac{1}{1+r}\left(\lambda_{t+1} + \mu_{t+1}\right) \ , \tag{12}$$

$$d_t + m_t \geq \gamma K_t \ \ , \ \ \mu_t \geq 0 \ \ , \ \ \mu_t(d_t + m_t - \gamma K_t) = 0 \ . \tag{13}$$

The optimality conditions for investment (6) and for the saver's capital accumulation (7) are standard. Conditions (9) for leisure and (8) for consumption yield the following condition relating their marginal rate of substitution to the aftertax real wage:

$$\frac{\kappa}{1-\kappa}\frac{c_t}{1-l_t} = w_t(1-\tau_t) \ . \tag{14}$$

On this margin a higher tax rate therefore creates a larger distortion.

Producers set the marginal product of labor equal to the real wage in accordance with (10). But from (11), when the financial constraint (4) binds so that $\mu_t > 0$, the marginal product of capital exceeds the return r^k_t paid out to the intermediary. The reason is that in order to rent capital producers need to also hold government bonds, which by (12) have a lower financial return when $\mu_t > 0$. The requirement to hold low-yield collateral makes it costlier to rent capital, so that firms reduce their capital stock. Any relaxation of the financial constraint requires a higher tax rate that can fiscally sustain a higher debt stock. A higher tax rate therefore reduces distortions on this margin. This effect goes in the opposite direction to the labor supply effect. It is the tension between these two effects which creates the policy trade-off discussed in Section 2 (Figure 3).

The optimality conditions for money and bonds can be combined to obtain a familiar looking first order condition for money demand:

$$\frac{v'\left(\frac{M_{t+1}}{P_t}\right)}{\lambda_t} = \frac{i^g_{t+1}}{1+i^g_{t+1}} \ . \tag{15}$$

Together with the assumption about a satiation point for real money balances this establishes the optimality of the Friedman rule, $i^g_{t+1} = 0 \ \forall t \geq 0$. This implies, from the Fisher equation, that a lower real financial return on government debt r^g_{t+1} calls for a higher inflation rate. A higher tax rate relaxes the financial constraint and thereby raises the financial return on bonds, up to the point where the financial constraint ceases to bind. Therefore, up to that point, *a higher tax rate lowers inflation*.

3.2 Intermediary

The intermediary is owned by households. It is competitive in the markets for savings and loans of productive capital. Its services are only required while goods and factor markets are open. During this period the intermediary accepts deposits of k_t from savers at the interest rate r^d_t and lends K_t to producers at the interest rate r^k_t. For simplicity the intermediary's net worth is assumed to be zero, so that it relies entirely on full loan collateralization to insure its solvency. This gives rise to the financial constraint (4). The following balance sheet constraint must hold:

$$k_t = K_t \tag{16}$$

The intermediary's zero profit condition is:

$$r_t^d = r_t^k \tag{17}$$

It is assumed that if the intermediary defaults on his obligation to repay the deposit, the saver has a claim on the intermediary's collateral assets in an amount equal to his deposit.

3.3 Government

The government's flow budget constraint is given by

$$\frac{d_{t+1}}{1+r_{t+1}^g} = d_t + g_t - \tau_t w_t l_t \tag{18}$$

and its lifetime budget constraint is therefore

$$d_0 = (\tau_0 w_0 l_0 - g_0) + \sum_{t=1}^{\infty} \left(\prod_{s=1}^{t} \frac{1}{1+r_s^g} \right) (\tau_t w_t l_t - g_t) \tag{19}$$

The process for lumpsum transfers $\{g_t\}_{t=0}^{\infty}$ is exogenous. *A government policy G* is defined as a sequence $\left\{i_{t+1}^g\right\}_{t=0}^{\infty}$ plus an optimal tax rate τ^{opt}. The government chooses its policy instruments to maximize households' lifetime utility, subject to its own lifetime budget constraint, agents' optimality conditions, and economy-wide resource constraints. The government is assumed to have access to a technology that allows it to credibly commit to the announced policies.

3.4 Equilibrium

An allocation is defined as a set of sequences $\{c_t, l_t, L_t, I_t, k_t, K_t, D_t, M_t\}_{t=0}^{\infty}$, and a *price system* as a set of sequences $\left\{\pi_t, w_t, q_t, r_t^k, r_t^d, r_{t+1}^g\right\}_{t=0}^{\infty}$. Then a competitive equilibrium is defined as follows:

*A **competitive equilibrium** given k_{-1}, D_{-1} and M_{-1} is an allocation, a price system and a government policy (including exogenous government spending) such that*

(a) given the price system and the government policy, the allocation solves the household's problem of maximizing (1) *subject to* (2), (5) *and* (4)*,*

(b) the price system and allocation satisfy the intermediary's balance sheet identity (16) *and zero profit condition* (17)*,*

(c) the labor market clears at all times

$$l_t = L_t \quad \forall t \, , \tag{20}$$

(d) the goods market clears at all times

$$c_t + I_t + \frac{\xi}{2}(\frac{I_t}{k_t} - \delta)^2 = l_t^{\alpha} k_t^{1-\alpha} \tag{21}$$

The government chooses a policy G at time 0, and households subsequently choose their allocations. In choosing optimal policies the government needs to predict how household allocations and prices will respond to its policies, taking into account the objective function (1) and the constraints (2), (5) and (4). An *allocation rule* is defined as a sequence of functions $A(G) = \{c_t, l_t, L_t, I_t, k_t, K_t, D_t, M_t \mid G\}_{t=0}^{\infty}$ that maps policies G into allocations, and a *pricing rule* is defined as a sequence of functions $P(G) = \left\{\pi_t, w_t, q_t, r_t^k, r_t^d, r_{t+1}^g \mid G\right\}_{t=0}^{\infty}$ that maps policies G into prices. Then the Ramsey equilibrium is defined as follows:

*A **Ramsey equilibrium** given k_{-1}, D_{-1} and M_{-1} is a government policy G, an allocation rule $A(.)$, and a pricing rule $P(.)$ such that*

(a) the government policy G maximizes household utility (1) *subject to the government's lifetime budget constraint* (19)*, with allocations and prices given by $A(G)$ and $P(G)$,*

(b) for every government policy $\tilde{G}$, the allocation $A(\tilde{G})$ and the price system $P(\tilde{G})$ together with the government policy $\tilde{G}$ are a competitive equilibrium.

It is clear from (15) that the Friedman rule must hold in every Ramsey equilibrium. The analysis can therefore focus on the optimal choice of fiscal policy τ^{opt}.

4. Optimal Fiscal Crisis Resolution

This section discusses the optimal policy response to unanticipated increases in fiscal transfer spending, specifically the optimal mix between higher distortionary labor taxation and higher distortionary inflation. For the following computational exercises parameter values are assigned as follows: $\alpha = 0.64$, $\theta = 1$, $\delta = 0.1$ (p.a.), $r = 0.08$ (p.a.), and $\gamma = 0.25$.[19] Initial steady state government transfer spending is set to $g = 0.1$, which corresponds to around 9% of GDP.

4.1 Steady States

Figure 4 displays the steady state values of key variables for a constant $g = 0.1$ and for different tax rates τ along the horizontal axis. The idea is to determine the steady state debt and therefore capital stocks that can be sustained by a given tax rate, along with the implied values of all other variables. These results are used as an input into Section 4.2, which discusses transitions between steady states.

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19 The share of leisure in utility κ is calibrated as the value consistent with the absence of a collateral constraint and a labor tax rate of 20%. A steady state proportion of time spent working of one third is assumed, as suggested by Kydland (1995) and the evidence cited there.

Figure 4 shows that as the tax rate is raised from relatively low levels, the stock of government debt that can be fiscally supported rises. This implies a lower value of the financial constraint multiplier and therefore a higher real financial return on government debt. Because this reduces the cost to producers of holding the collateral asset, it induces them to expand the physical capital stock. Relaxing the financial constraint therefore corresponds to the outward shift of the production possibilities frontier in Figure 3. At the same time a higher tax rate distorts and reduces labor supply. At relatively low tax rates the first effect dominates and steady state output increases with the tax rate despite the reduction in labor input. Over this range of taxes welfare increases in the tax rate, as both consumption and leisure increase. All of the panels in Figure 4 have a kink and welfare maximum at a tax rate of 19.19%.[20] This is the point at which the financial constraint ceases to bind so that the only effect of higher taxes is to increase the labor supply distortion. At this point the debt/GDP ratio is just over 50%. It will be shown that this tax rate is not optimal in a dynamic setting because it is not time consistent.

4.2 Optimal Response to a Fiscal Shock

Methodology and Preliminary Results

The computation of optimal transition paths in response to changes in g is complicated by the fact that the Ramsey problem is not recursive. Optimal choices at time 0 depend on control variables many periods into the future, due to the constraint imposed by government intertemporal solvency. Aiyagari et al. (2002) discuss this problem in detail for an economy without state-contingent debt and without capital. Capital accumulation with both adjustment costs and a financial constraint makes the problem much harder to solve. But as shown in the Technical Appendix, a computable general equilibrium method can be used to obtain solutions for an economy without uncertainty. These solutions exhibit several new and interesting results that will be present in both nonstochastic and stochastic economies.

The idea of the solution method is to solve the entire nonlinear system of optimality conditions and resource constraints simultaneously for a large number of periods, including the government's lifetime budget constraint. The infinite dimensionality of that problem is reduced by imposing and then verifying convergence of the system to a new steady state within a finite number of periods. This solves for the solution paths of all variables, including their new steady state values.

A key question concerns the fractions of the increase in spending that are optimally financed by taxation and inflation. The former is computed from the optimal solution paths by evaluating the increases in the present discounted values of spending and of tax revenue using the preshock real interest rate for discounting, and expressing the latter as a fraction of the former. The remainder is accounted for by higher inflation and therefore lower real interest rates, which increases the present discounted value of future primary surpluses.

The Appendix shows three preliminary results for model variants that ignore the two key constraints imposed in this paper, the financial constraint and the constraint on the time profile of labor tax rates. In all cases government spending is held constant at $g = 0.1$.

[20] The vertical lines in the graphs are inserted at this tax rate.

First, without either constraint it is optimal to inflate away all debt in the initial period and thereby to reduce distortionary taxes by the maximum possible, to 13.88%. The Lucas (1987) welfare gain of doing so is a 0.65% compensating consumption variation. Second, with a financial constraint but still allowing for arbitrary paths of the labor tax rate, the longrun optimal tax rate corresponds to the kink at 19.19% in Figure 4 where the constraint ceases to bind. This is a version of the zero long-run taxation of capital (via the inflation tax on debt) result. Third, with a financial constraint the government's incentive to inflate away all of its debt disappears. But it can still realize a welfare gain of 0.28% by reducing the tax rate very drastically at time 0 (actually, subsidizing labor at around 10%) and then letting it return to its initial value. Fiscally, the temporary loss of labor tax revenue is compensated by a temporary surge in inflation. The model as it stands does account for the (small) benefits of such a policy, but it does not account for the large political and resource costs discussed in the Introduction. The analysis therefore proceeds under the additional assumption that for any given sequence of spending $\{g_t\}_{t=0}^{\infty}$ the government can choose only one constant tax rate τ^{opt}.

Figure 5 derives the optimal policy for the complete model with both constraints and a constant $g = 0.1$. The dotted line in both plots represents steady state welfare at different tax rates, taken from Figure 4. The experiment behind the solid line in the left hand side plot is as follows: Fix the initial debt and capital stocks at the values consistent with the optimal steady state tax rate of 19.19%. Then set the tax rate to a lower level, compute the transition paths to the associated steady state, and evaluate welfare. The plot shows that the optimal steady state tax rate is time inconsistent because welfare can be raised by lowering the tax rate and thereby reducing the debt and capital stocks. The maximum welfare gain is achieved by a significant 2.90% reduction in taxes to 16.29%. The second plot confirms that this tax rate, which can be shown (computationally) to be unique in that it is independent of initial conditions, is not time inconsistent. Once debt and capital have reached the steady state values consistent with that rate, welfare cannot be improved by changing taxes. At this rate labor is taxed less than at the optimal steady state, but capital is taxed even in the long run. In other words, both the labor supply distortion and the inflation distortion are present at the optimum. The associated values for debt and capital are the natural starting values for the analysis of optimal responses to fiscal shocks in the following exercises.[21]

A Permanent Spending Increase

Consider a permanent 5% increase in government transfer spending. The new Ramsey tax rate is 16.90%.The first 6 panels of Figure 6 show how this shares the fiscal burden of the higher spending level. Because of the binding financial constraint and the given initial capital stock, the initial price level does not jump at all to revalue the debt stock. Instead, the fiscal contribution of price level changes comes entirely from higher ongoing inflation and therefore a lower real interest rate on government debt, in other words through increased seigniorage on debt. But this only finances 24% of the increase in government spending, with 76% financed through higher labor taxes.

[21] To avoid terminological confusion the paper does not refer to these as "time consistent" or "sustainable" steady states, as these terms have a specific meaning in the literature on reputational equilibria. The concepts are nevertheless similar in that in both cases there is no benefit to short-run deviations from a long run optimum.

As a result of the higher tax rate labor supply drops immediately, resulting in an initial drop in the marginal product of capital. But the tighter financial constraint and higher inflation have a negative effect on intermediation and thereby reduce the optimal capital stock over time. The final steady state marginal product of capital is therefore higher, thereby compensating borrowers for the lower return on government bonds. As both labor and capital inputs are eventually reduced, output and consumption also drop, by around 0.5%. Therefore fiscal spending, even though it is a pure lump sum transfer, is nonetheless contractionary because it forces the government to increase both the tax and the inflation distortions.

Finally, it is interesting to note that the assumption of full commitment is not very restrictive here. A government without access to a commitment technology would, at least in the long run, choose exactly the same tax rate as the Ramsey planner.

A Temporary Spending Increase

Consider now a temporary (four year) 10% increase in transfer spending. It can be shown that for a permanent 10% spending increase the tax rate would optimally increase to 17.51%. But as shown in Figure 7, for the temporary case the tax rate only increases by 0.12% to 16.41%. This limited tax response to much higher spending means that new debt issuance must increase sharply relative to the capital stock, and that inflation must rise immediately to make a significant contribution to government solvency. Because of this higher inflation, and because higher labor taxation reduces the labor supply, the optimal capital stock starts to decline, and real debt declines along with it because higher inflation lowers the real financing cost of the debt sufficiently to more than offset increased debt issuance. It is evident from Figure 7 that the short-term fiscal burden is mostly borne by inflation. But in the long run, taxation still bears 59% of the overall burden of adjustment, because a higher rate of taxation results in a healthier fiscal situation once the high spending period ends. At that time it relaxes the financial constraint and increases the interest rate on debt, so that from that time onwards the financing cost of the debt is in fact higher than in the initial steady state. As discussed in the Introduction, this pattern of taxation and inflation is very intuitive, because policymakers find it politically far less costly to use inflation to satisfy temporary revenue needs rather than repeatedly adjusting the labor tax rate. And importantly, despite the large increase in spending, the temporary increase in inflation is not excessive at around 2%. This is because in this model the base of the inflation tax is far larger than the stock of base money, it includes a debt stock that equals around 50% of annual GDP. As for output, there is a significant contraction during the high spending phase due to lower supplies of both labor and capital. But eventually the higher tax rate shifts out the production possibilities frontier via higher debt and capital stocks, and output recovers beyond its original level.

The most remarkable aspect of Figure 7 is that the intertemporal pattern of inflation is purely determined by fiscal factors. Of course this does depend on monetary accommodation, but any such accommodation is an optimal response.

When the exercise in Figure 7 is repeated for a shorter, one year increase in g by 10%, all qualitative features of the responses remain unchanged. But the optimal tax rate now changes only minimally (it increases by 0.01%), and 82% of the burden of fiscal adjustment falls on inflation. Essentially, the fiscal disturbance is so short-lived that the resulting temporary and quite modest increase in inflation does not do so much harm to intermediation as to justify a large permanent change in the tax rate.

The above examples show that the optimal response to a fiscal crisis depends not only on the size of the initial fiscal imbalance (in present value terms) but also on its duration. For very short-lived fiscal shocks it is optimal to balance the budget mostly through higher inflation, essentially seigniorage on debt, while for very long-lived shocks the burden of adjustment should mostly be on taxation.

5. Conclusion

The paper has developed a model of fiscal andmonetary policy that aims to shed newlight on the policy trade-offs involved in the resolution of fiscal crises. It makes two assumptions that reflect the constraints often faced by policymakers in such situations. First, policymakers are very apprehensive of simply inflating away the public debt. Data were shown to argue why such a policy may be highly damaging to financial intermediation. Constraints of this nature, which are incorporated into the model as a financial constraint linking the capital stock to the debt stock, are frequently encountered in the negotiation of fiscal adjustment programs in emerging markets. Second, frequent changes in taxation are much harder to implement than a one-time tax adjustment combined with a time-varying inflation tax on debt. The model therefore restricts attention to Ramsey equilibria with constant labor tax rates for any given spending sequence.

The key contribution of the paper is the construction of a theoretical model in which unanticipated inflation is socially costly because of its effect on the real debt stock and thereby on intermediation and production. Because higher distortionary taxation is required to support a higher debt stock, higher distortionary taxation permits lower distortionary inflation. This makes price level and inflation determination the result of a meaningful government optimization problem that trades off the costs of taxation and inflation. Furthermore, the fact that debt enters the economy's intermediation technology implies that part of the debt return is nonfinancial. Inflation can therefore be used to levy seigniorage on debt. Because debt is generally much larger than base money, the fiscal leverage of moderate ongoing inflation increases dramatically.

The model therefore clearly articulates a channel through which fiscal policy alone can drive *inflation*, and without reliance on seigniorage on a generally small stock of base money. Discussions of monetary policy for emerging markets acknowledge that fiscal dominance remains a serious problem there, but typically this is not reflected in the models used, where fiscal policy most often consists of Ricardian lump-sum transfers. The main alternatives are the fiscal theory of the price level and the optimal fiscal policy literature. But the former, apart from not being based on optimizing government behavior, does make the problematic prediction that motivated the assumption of a financial constraint, namely that serious fiscal imbalances can be painlessly resolved through large price level jumps. This conclusion is only slightly modified by the optimal fiscal policy literature, which has the additional problem that it cannot easily rule out infinite first period inflation. On a theoretical level, neither theory exhibits fiscal dominance in the determination of average inflation. And on a practical level, neither theory can provide much guidance in thinking about the burden-sharing between taxation and inflation in the resolution of a fiscal crisis. These have been important objectives of this paper, and it can claim some success.

Specifically, the computed examples suggest that permanent spending shocks should be financed mainly through tax increases, while the contribution of temporary increases in inflation should increase as shocks become more short-lived. The specific quantitative results are at this stage of course subject to considerable uncertainty, given limited knowledge about both the functional form and the correct parameterization of the intermediation technology.

This research can be expanded into several interesting directions. Work in progress includes a real debt version of the paper that addresses the closely related question of optimal outright default on real debt. Further ahead, it may be useful to insert this model into a framework with either nominal rigidities or private sector learning about monetary policy shocks. This would make monetary policy more interesting than in the current model, and may permit an analysis of optimal monetary and fiscal policy rules under both monetary *and fiscal* shocks. The advantage of the current model is of course that it exhibits the underlying fiscal driving forces of inflation much more clearly.

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Appendix Unconstrained Ramsey Plans

The figure 8 show Ramsey plans for model variants that ignore one or both of the two key constraints imposed in this paper, the financial constraint and the constraint on the time profile of labor tax rates. In all cases government spending is held constant at $g = 0.1$. The dotted line represents an economy without either constraint. The solid line represents an economy with a financial constraint but without a constraint on the labor tax profile.

Table 1. Domestically-Issued versus Externally-Issued Government Debt*

Country	Domestic Debt/GDP	External Debt/GDP	Domestic Debt/ Total Debt	Dom. Ccy. Debt/ Total Dom. Debt
Argentina	15.4	36.4	**30**	18
Brazil	35.8	18.5	**66**	80
Chile	27.3	8.8	**76**	92
Colombia	12.4	24.5	**34**	93
India	64.9	20.6	**76**	100
Korea	41.6	21.1	**66**	100
Malaysia	35.1	30.7	**53**	98
Mexico	9.5	26.8	**26**	100
Philippines	43.0	48.8	**47**	100
Thailand	34.6	41.5	**45**	100
Turkey	24.4	36.5	**40**	78
Venezuela	7.4	32.6	**19**	100

* Average for 1996-2000, except for domestic debt to GDP ratio in Korea (1997-2000).

Figure 1a. Argentina

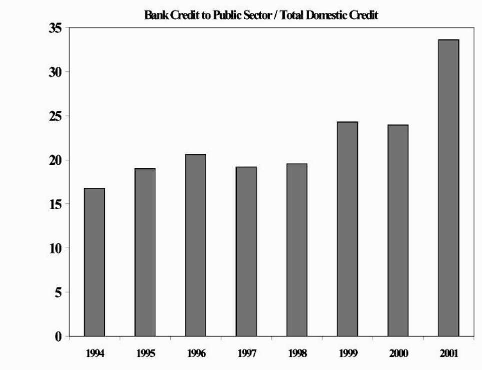


Figure 1b. Latin America

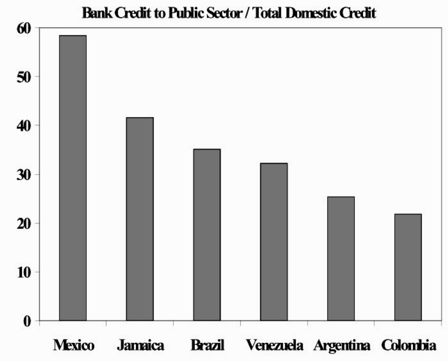


Figure 1c. Asia

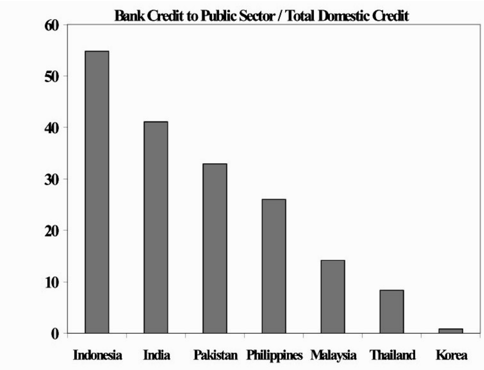


Figure 1d. Transition Economies

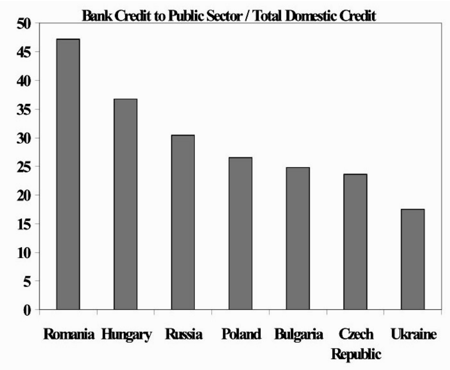


Figure 1e. Middle East

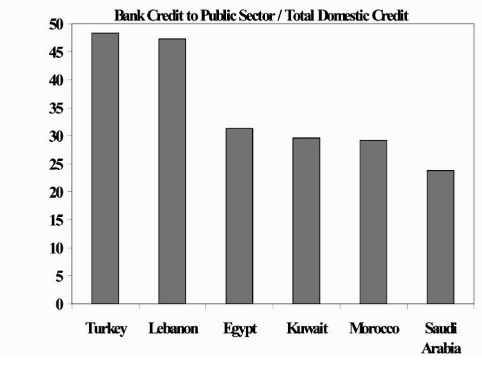


Figure 1f. Industrial Countries

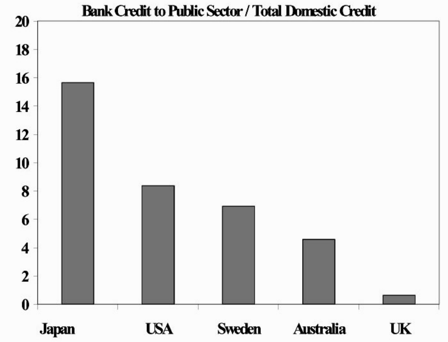


Figure 2. Economic Environment

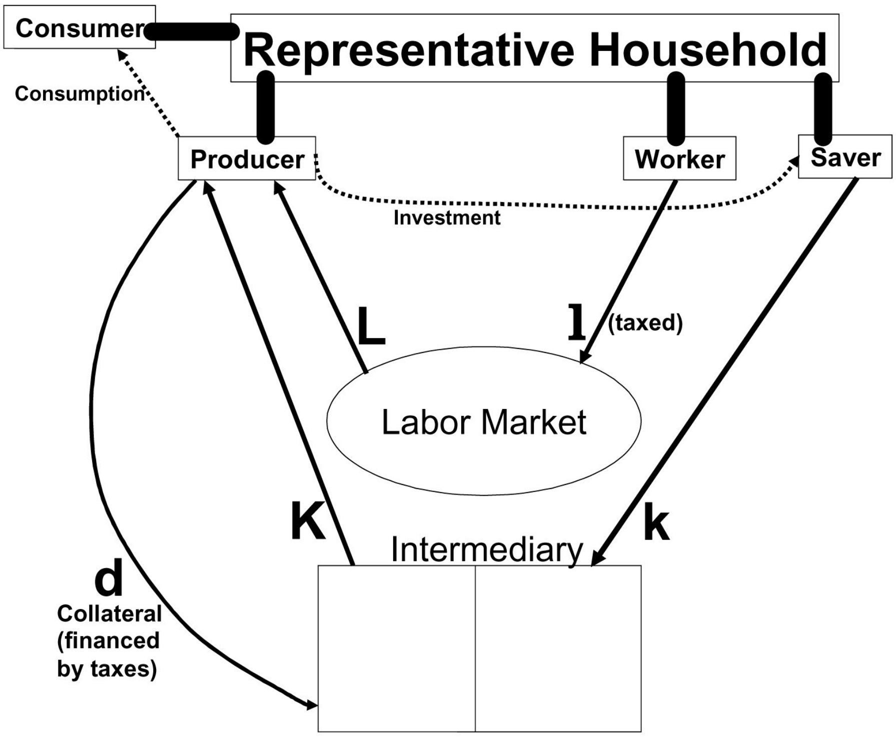


Figure 3. Trade-Off Between Fricitions

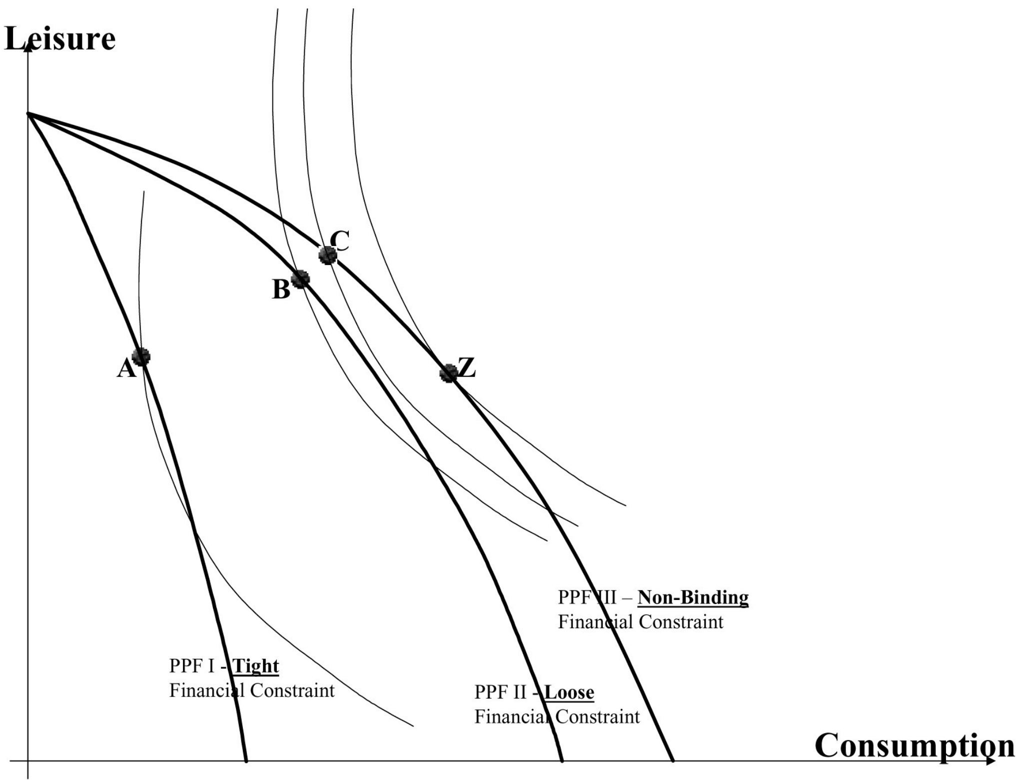


Figure 4.

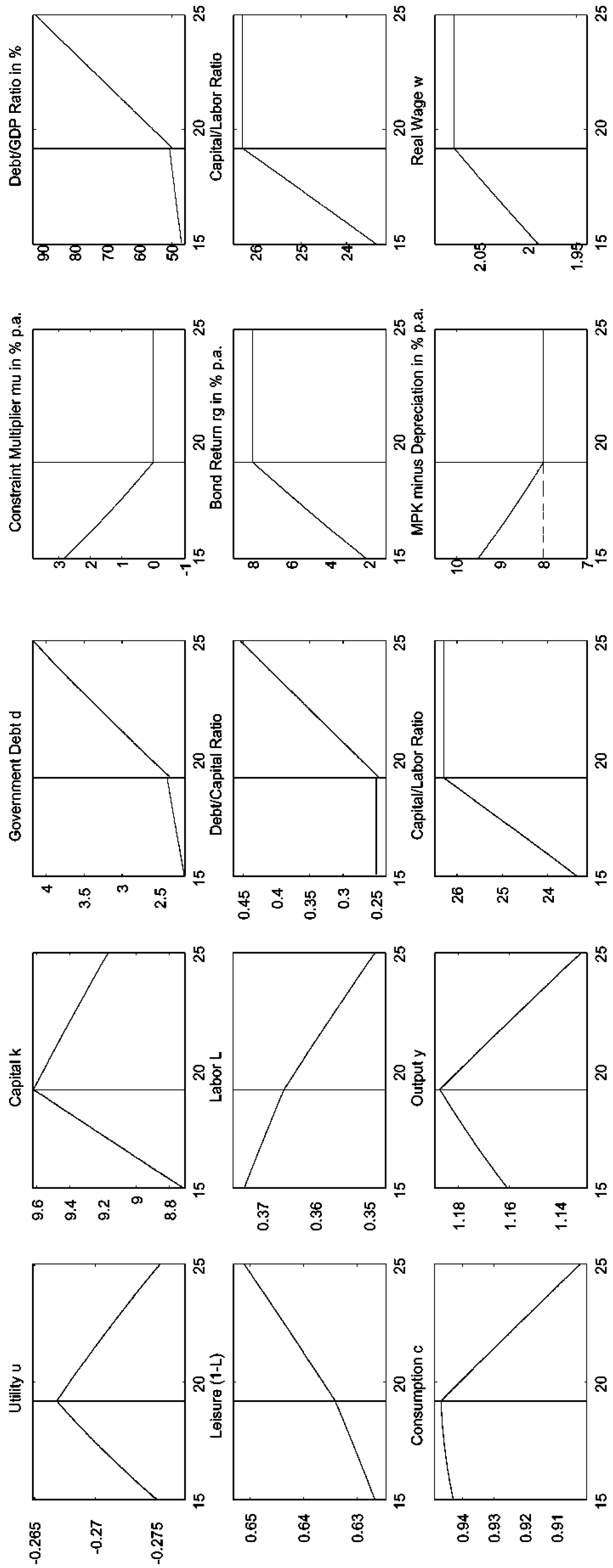
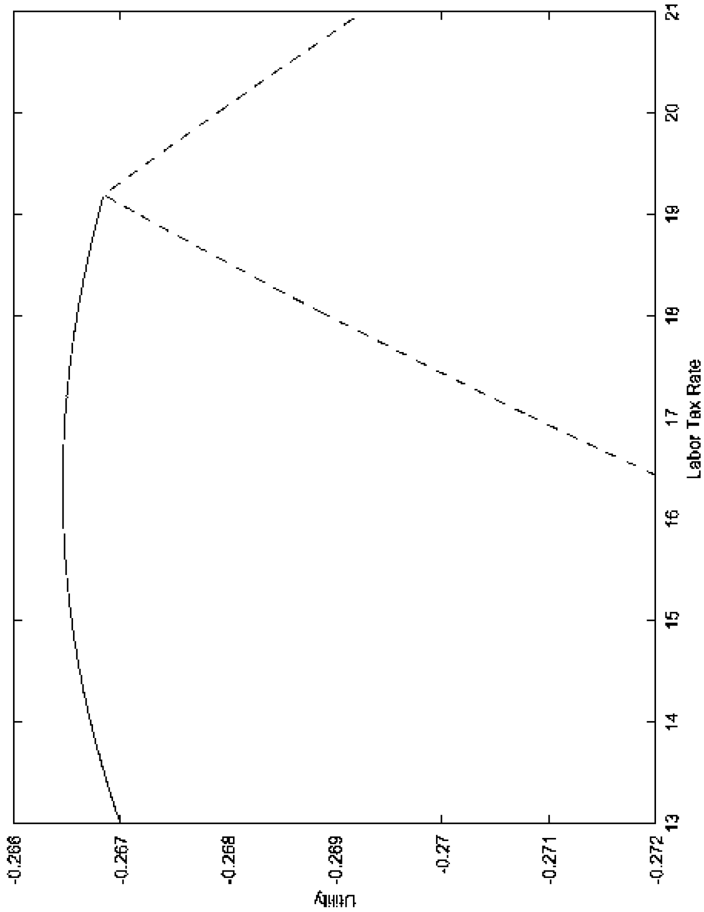
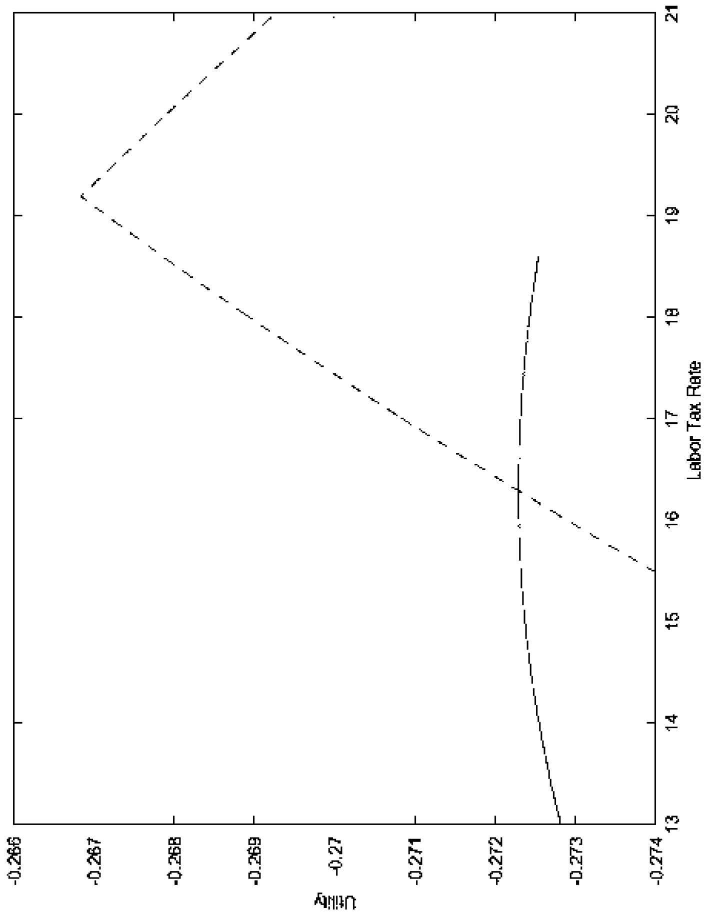

Utility u
Capital k
Government Debt d
Constraint Multiplier mu in % p.a.
Debt/GDP Ratio in %
Leisure (1-L)
Labor L
Debt/Capital Ratio
Bond Return rg in % p.a.
Capital/Labor Ratio
Consumption c
Output y
Capital/Labor Ratio
MPK minus Depreciation in % p.a.
Real Wage w

Figure 5.



Tax Rate= 19.19%



Tax Rate= 16.29%

Figure 6.

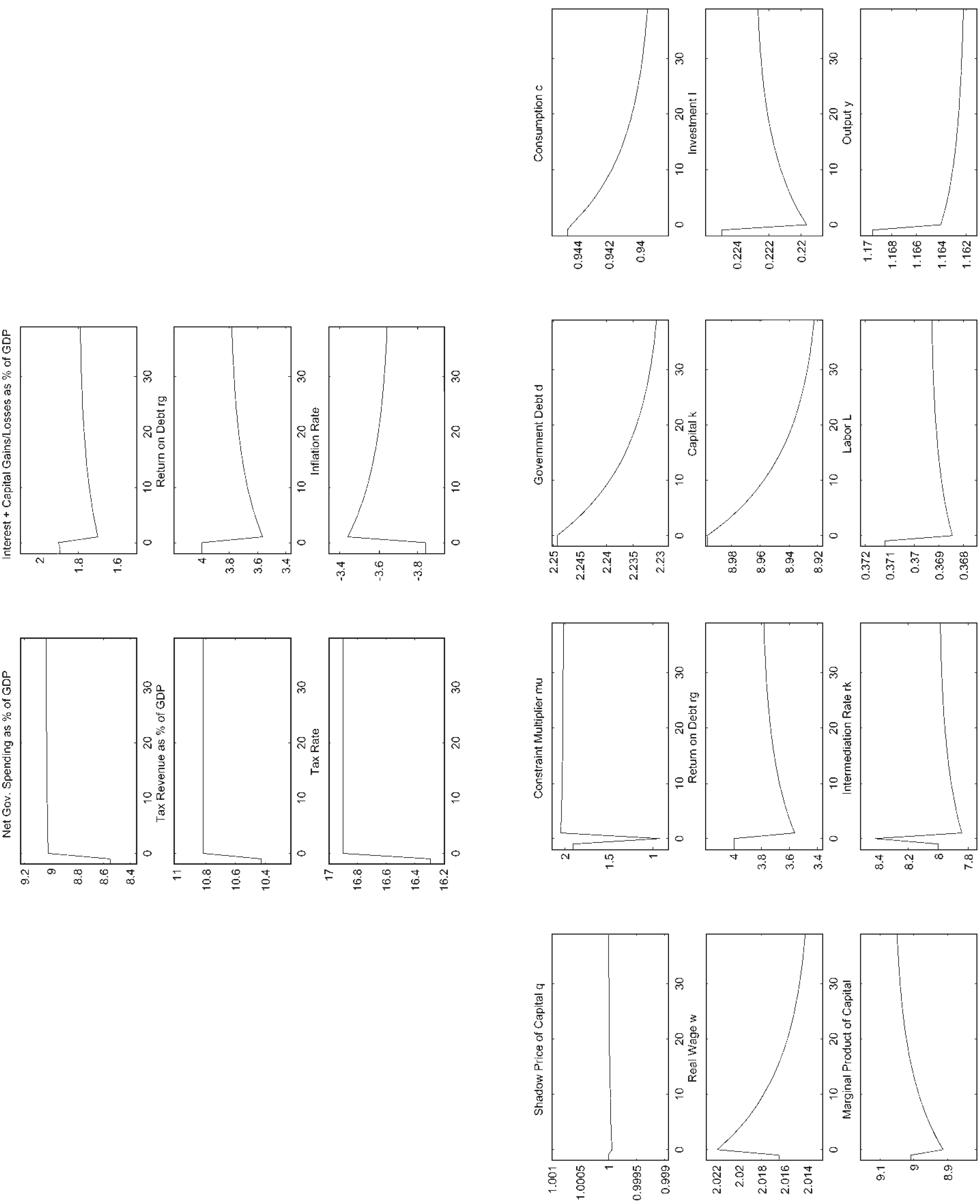
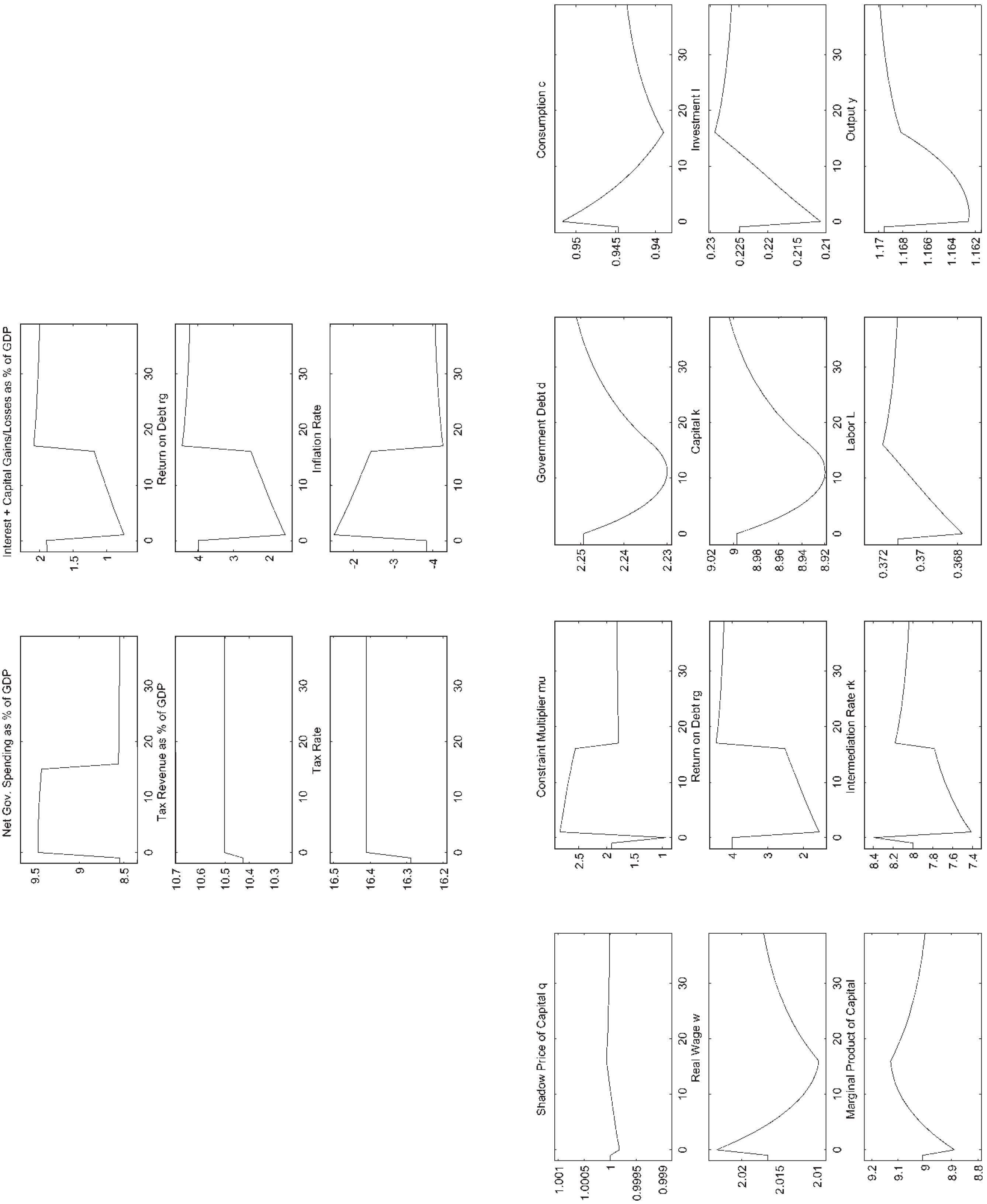

Net Gov. Spending as % of GDP
Interest + Capital Gains/Losses as % of GDP
Tax Revenue as % of GDP
Return on Debt rg
Tax Rate
Inflation Rate
Shadow Price of Capital q
Constraint Multiplier mu
Government Debt d
Consumption c
Real Wage w
Return on Debt rg
Capital k
Investment I
Marginal Product of Capital
Intermediation Rate rk
Labor L
Output y

Figure 7.


Net Gov. Spending as % of GDP
Interest + Capital Gains/Losses as % of GDP
Tax Revenue as % of GDP
Return on Debt rg
Tax Rate
Inflation Rate
Shadow Price of Capital q
Constraint Multiplier mu
Government Debt d
Consumption c
Real Wage w
Return on Debt rg
Capital k
Investment I
Marginal Product of Capital
Intermediation Rate rk
Labor L
Output y

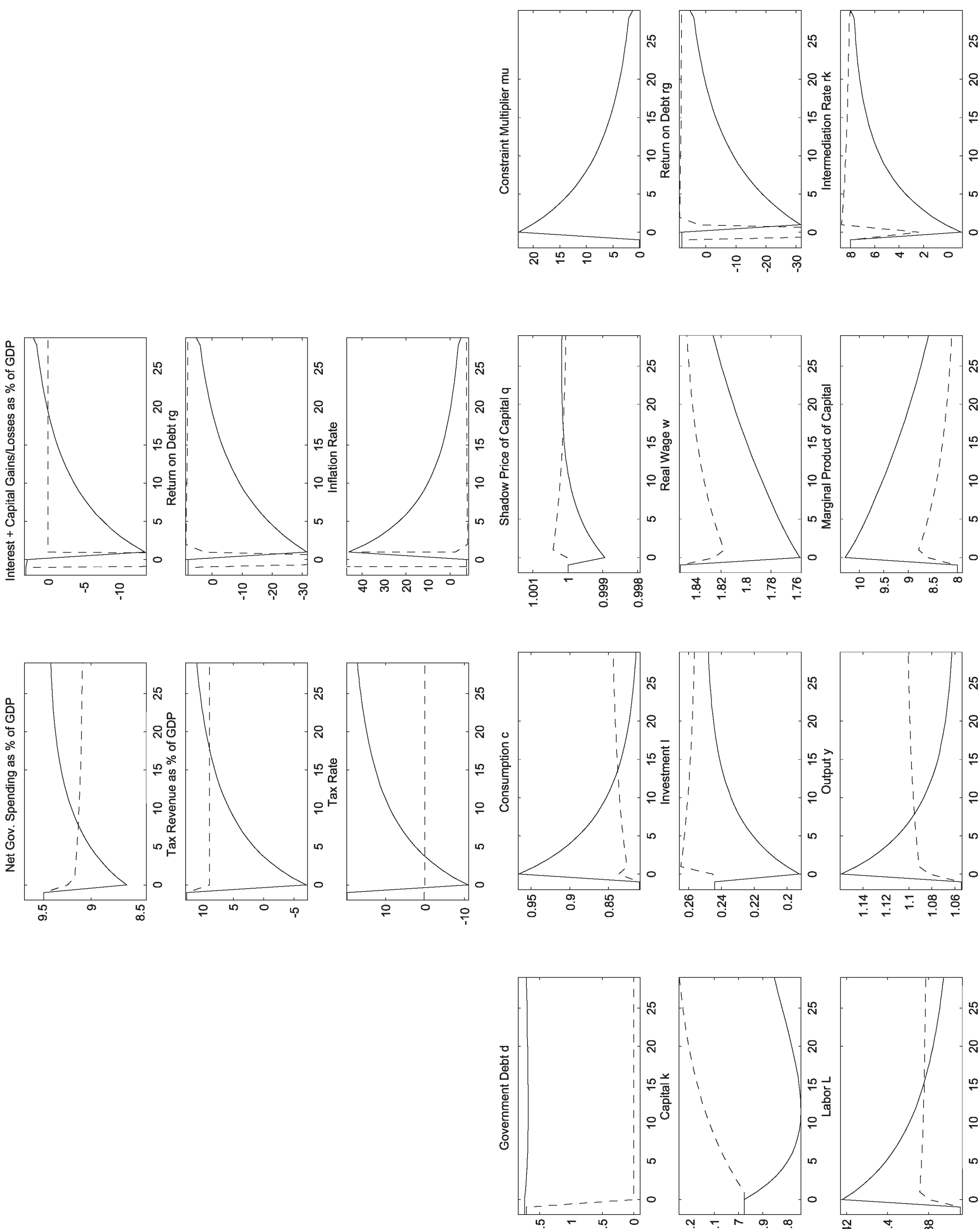

Net Gov. Spending as % of GDP
Interest + Capital Gains/Losses as % of GDP
Tax Revenue as % of GDP
Return on Debt rg
Tax Rate
Inflation Rate
Government Debt d
Consumption c
Shadow Price of Capital q
Constraint Multiplier mu
Capital k
Investment I
Real Wage w
Return on Debt rg
Labor L
Output y
Marginal Product of Capital
Intermediation Rate rk

Figure 8.